MONTHLY WEATHER REVIEW.

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INTRODUCTION.

The MONTHLY WEATHER REVIEW for May, 1904, is based on data from about 3300 stations, classified as follows:

Weather Bureau stations, regular, telegraph, and mail, 167; West Indian Service, cable and mail, 4; River and Flood Service, regular 43, special river and rainfall, 190, special rainfall only, 56; voluntary observers, domestic and foreign, 2565; total Weather Bureau Service, 3025; Canadian Meteorological Service, by telegraph and mail, 20, by mail only, 13; Meteorological Service of the Azores, by cable, 2; Meteorological Office, London, by cable, 8; Mexican Telegraph Company, by cable, 3; Army Post Hospital reports, 18; United States Life-Saving Service, 9; Southern Pacific Company, 96; Hawaiian Meteorological Service, 75; Jamaica Weather Service, 130; Costa Rican Meteorological Service, 25; The New Panama Canal Company, 5; Central Meteorological Observatory of Mexico, 20 station summaries, also printed daily bulletins and charts, based on simultaneous observations at about 40 stations; Mexican Federal Telegraph Service, printed daily charts, based on about 30 stations.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Mr. R. C. Lydecker, Territorial Meteorologist, Honolulu, Hawaii; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. S. I. Kimball, Superintendent of the United States Life-Saving Service; Lieut. Commander H. M. Hodges, Hydrographer, United States Navy; H. Pittier, Director of the Physico-Geographic Institute, San José, Costa Rica; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Secretary, Meteorological Office, London; Rev. José Algué, S. J., Director, Philippine Weather Service; and H. H. Cousins, Chemist, in charge of the Jamaica Weather Office; Señor Enrique A. Del Monte, Director of the Meteorological Service of the Republic of Cuba.

Attention is called to the fact that the clocks and self-registers at regular Weather Bureau stations are all set to seventy-fifth meridian or eastern standard time, which is exactly five hours behind Greenwich time; as far as practicable, only this standard of time is used in the text of the REVIEW, since all Weather Bureau observations are required to be taken and recorded by it. The standards used by the public in the United States and Canada and by the voluntary observers are believed to conform generally to the modern international system of standard meridians, one hour apart, beginning with Greenwich. The Hawaiian standard meridian is 157° 30′, or $10^h\ 30^m$ west of Greenwich. The Costa Rican standard meridian is that of San José, $5^h\ 36^m$ west of Greenwich. Records of miscellaneous phenomena that are reported occasionally in other standards of time by voluntary observers or newspaper correspondents are sometimes corrected to agree with the eastern standard; otherwise, the local standard is mentioned.

Barometric pressures, whether "station pressures" or "sea-level pressures," are now reduced to standard gravity, so that they express pressure in a standard system of absolute measures.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

May weather presented no unusual features on the North Atlantic Ocean, and the coasts and Great Lakes of the United States were not visited by severe storms.

Heavy rains occurred in the Middle-western States and at the close of the month the rivers of Kansas were in flood.

Drought continued in New Mexico and Arizona, and the early part of the month was very dry in Texas and the South Atlantic States.

Severe local storms were reported from Iowa and Kansas to northern Texas on the 5th, in Virginia on the 18th, and in Kansas on the 25th. During the afternoon of the 30th a well-defined tornado occurred about 12 miles west of Mobile, Ala.

NEW ENGLAND FORECAST DISTRICT.

The weather of the month was very pleasant, with more than the usual number of fair days and an abundance of sunshine. Frosts were general during the early part of the month, but caused no serious damage. No high winds occurred along the coast.—*J. W. Smith, District Forecaster.*

WEST GULF FORECAST DISTRICT.

Local thunderstorms, accompanied in some instances by high winds, occurred on several dates, and storm warnings were issued on two dates.—*I. M. Cline, District Forecaster.*

NORTH CENTRAL FORECAST DISTRICT.

The weather was without special characteristics. A few storms of moderate strength, for which warnings were issued, passed over the upper Lakes, but no wrecks or damage were reported. Frost warnings were issued on two or three occasions.—*H. J. Cox, Professor and District Forecaster.*

ROCKY MOUNTAIN FORECAST DISTRICT.

On the 1st to 3d and on the 19th and 20th heavy rains fell on the middle-eastern slope of the Rocky Mountains, and during the first period snow fell in the mountain region, the fall being very heavy in the foothill districts, notably at Cripple Creek, where the depth exceeded two feet. The rain of the 19-20th caused considerable damage in Wyoming and north-central Colorado. A heavy downpour of rain in the hills west of Cheyenne, Wyo., caused a destructive flood to sweep through a part of Cheyenne during the night of the 20th, drowning two children and damaging much property. In Colorado the damage was confined principally to the Valley of the Poudre and Greeley, where for a distance of 35 miles crops were washed out or covered with mud or débris; fences, outbuildings, bridges, etc., were washed away and considerable live stock drowned. Unfortunately for live stock and agricultural interests, the precipitation of the month did not extend far enough southward to break the drought prevailing in Arizona and New Mexico. The severe frosts that occurred in the high districts were accurately forecast, as well as the light frosts that visited the important agricultural and fruit growing dis-

tricts. The damage by frosts, if any, was small.—*F. H. Brandenburg, District Forecaster.*

SOUTH PACIFIC FORECAST DISTRICT.

The month was quite uneventful. Over the greater portion of the State no rain fell. In the extreme north and extreme south there were a few light showers.—*A. G. McAdie, Professor and District Forecaster.*

NORTH PACIFIC FORECAST DISTRICT.

The month was unusually dry with nearly normal temperatures. At Portland, Oreg., the river was above the danger line throughout the month, but as ample warning of the coming stages were issued several days in advance precautionary measures were taken to prevent avoidable losses.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

The Mississippi River fell steadily after the high stages of the preceding month, remaining, however, above the danger line at New Orleans until the 23d. The Missouri also fell generally, but during the last few days of the month heavy rains over the lower watershed, including that of the Kansas River, started a rapid rise, which by the end of the month had become manifest in the Mississippi between Alton, Ill., and the mouth of the Ohio. In the lower Kansas Valley the waters of course did not reach by many feet the abnormal heights of the preceding year. Nevertheless, considerable damage was done between Topeka and Kansas City, principally by the flooding of lowlands. In the vicinity of Kansas City the damage was much greater. Several temporary pile bridges over the Kansas River were swept away, and the bottoms were covered with water. Many of the inhabitants were driven from their homes. Business was suspended in some localities, and railroad service badly demoralized.

During the first decade of the month the high water in the Mississippi River caused considerable damage in the vicinity of Cairo. On the Illinois side of the river hundreds of acres of wheat were submerged and destroyed, while on the Missouri side the loss to the St. Louis and San Francisco Railroad between St. Louis and Poplar Bluff, Mo., was about $100,000.

The following report on the spring flood in the Memphis district, where the highest proportionate stages were reached, was prepared by Mr. S. C. Emery, Official in Charge of the United States Weather Bureau office, Memphis, Tenn. This report will be found to be very interesting. It apparently decides a much mooted question that arose during the close of the flood of 1903, as to the effect of the railroad embankments opposite in ponding the water above. It now seems that the embankments were not seriously at fault, the surplus water having come through a 10-mile gap near the upper end of Reelfoot Lake district. This water left the main stream in the vicinity of Hickman, Ky., and reentered it in the neighborhood of Fulton, Tenn. Mr. Emery also remarks that for the first time the St. Francis levee successfully resisted a severe flood.

Moderately low river stages prevailed in the Memphis district throughout the winter months, and until March 1 the water was considerably below normal. As this was later than the usual time for the formation of floods, it was generally thought that no serious rise was likely to occur this year, and farmers and levee contractors began the season's work. During the first ten days in March two sharp swells started in the upper Ohio, the crests of which soon merged into one and reached Cairo during March 17, with a stage of 36.2 feet. On March 11, twelve days previous to the arrival of the crest of the rise at Memphis, announcement was issued from the Memphis office that the maximum stages in that district would be as follows: New Madrid, 29 feet; Memphis, 25 feet. On March 16 the estimate for Memphis was increased to 26.5 feet, and a stage of between 35 and 36 feet predicted for Helena, Ark. The repeated assertion that the water would not exceed the estimates given was generally accepted, and work along the river continued without interruption. The greatest variation from the predicted stages and those that actually occurred was 0.3 of a foot, while the average time given was eight days. The maximum stages on this rise were as follows: New Madrid, 29.1; Memphis, 26.8; and Helena, 35.1 feet. After the passing of this wave, the river fell slowly for a few days, the total fall being only two feet, when the decline was arrested by a second swell, which was first felt at Cairo on March 25. This rise was caused by general and heavy rains throughout Missouri, Illinois, Indiana, and Kentucky, swelling the Ohio at a rapid rate, and many of its tributaries to unprecedented stages. The Mississippi above Cairo also rose rapidly for several days, so that by March 30 it was apparent that a flood of considerable magnitude was on its way to this section.

On March 30 warning bulletins were mailed to every post office in the district and to all interests likely to be affected to prepare for a stage exceeding 36 feet on the Memphis gage. On the following day a second warning was issued to the effect that the stage would exceed 37 feet at Memphis, and reach at least 47 feet at Helena. The prediction was also made that New Madrid would have a stage of at least 38 feet. The people were warned that the stages indicated would severely tax the levees in the St. Francis district, and to be prepared for possible breaks. On April 6 the river at New Madrid, after rising slowly during the four preceding days, came to a stand at a stage of 38.6 feet. From the fact that the crest had passed New Madrid and the rise at Memphis from April 1 to 6 was only moderate and slowly decreasing, doubts were freely expressed regarding the probability of the Memphis stage reaching the 37-foot mark as predicted. On the latter date, however, the rise suddenly and unexpectedly increased to one foot or more per day, and continued at that rate for three days, carrying the water about one and one half feet above the highest estimate heretofore made. This unlooked for rise is now known to have been caused by the ponding of water in the Reelfoot country, which lies immediately south of Hickman, Ky.

This water entered that basin through a 10-mile gap near the upper end of the Reelfoot Lake district, and, after making its way slowly through the wooded lowlands, where it increased in volume, again entered the main stream near Fulton and Fort Pillow, Tenn. In that way the water passed around New Madrid and caused the deceptive changes recorded by that and other gages as far south as Osceola, Ark. This accumulated water then poured out upon the top of the flood, and raised the stage at Fulton about 3 feet in as many days. The ponding of water in the Reelfoot basin is due in a great measure to the changed conditions brought about through the extension of the levee system, which has raised the flood level to a height heretofore unknown, causing a deflection of the water into new channels. From an examination of the records obtained during the flood of 1903, it is seen that after the water had reached the highest stage at New Madrid, the Fulton gage indicated the same sudden increase noted this year, and for about four days the river rose over 1 foot a day. This information is important, as it clearly indicates that the remarkable rise that occurred at Memphis during the three days next preceding the arrival of the crest at that place in both 1903 and 1904 was probably due to the outpouring of water from the Reelfoot basin, and not, as was formerly supposed, to an engorgement produced by the railroad embankments in front of Memphis on Hopefield Point. These embankments may have had some effect on the stage at Memphis, but the main cause must be attributed to deflection of the water into the Tennessee basin, which has the same effect as the St. Francis basin formerly had on the Helena gage when the water was permitted to overflow that section.

The wave crest reached Memphis April 11 with a stage of 39 feet, and Helena on the 15th, the stage at that place being 47.7 feet. Warnings for the above stages were given two days in advance at Memphis and five days at Helena. The water remained above the danger line in this district, as follows: New Madrid 20, Memphis 19, and Helena 22 days. During the week preceding and the one following the arrival of the crest, all of the levees fronting the St. Francis basin were in a very critical condition, and had all the water they could hold. By prompt action on the part of the engineers and the employment of several hundred men the weak places were repaired, and a topping of sand bags placed wherever the height appeared insufficient. Notwithstanding the extreme height of the water, the continued rains, and other unfavorable weather conditions, the levees were held intact throughout the entire system, and marked the first successful resistance to the encroachment of the water on the St. Francis basin.

Compared to the flood of 1903, the stage at Cairo was 1.5 feet lower, New Madrid 0.9 of a foot lower, Memphis 1.1 feet lower, and Helena 2.3 feet lower. All of the island plantations and the lowlands in Arkansas that lie outside the levee were entirely covered, and the extreme southern portion of the St. Francis basin in the counties of Lee and Phillips, where no levee exists, was also flooded as usual. On the Tennessee side a large territory was inundated, causing considerable damage and great inconvenience to the dwellers in that section. In and about Memphis the flood was about as severe as in 1903, but as the people were better prepared, the damage was slight.

During the progress of the flood the Weather Bureau office was hourly besieged by anxious inquirers from far and near, while the telephone calls were more frequent than ever before known. The daily stages at all important points, and the daily forecasts were sent by telephone and telegraph to a large number of places for distribution to the adjacent